Report
Farm & Crop Analysis using Remote Sensing for Vineyard Management

The objective of the pilot was to analyze 2 farms and understand the following points -

1. Plant Stress Analysis
2. Weed Analysis
3. Plant Disease Analysis
4. Water Stress Analysis
5. Plant Population

The analysis was performed using Sentinel-2 imagery since it has 10m bands for Red and NIR, and 20m bands for Short Wave Infrared.

Although **NDVI** was the chosen **vegetation activity** index in this analysis, a more soil-noise and saturation resistant index such as EVI2 or kNDVI can also be chosen, to make pinpointing the outliers more precise.

For Water Stress, **NDMI** or Normalized Difference Moisture Index was chosen, as it has a strong relationship with the thermal perfomance of the crop canopy which is directly related how well watered and cool the plants are. This is due to the use of SWIR bands, which interact more with the Leaf Water content, and less with the Leaf Chlorophyll content.

And both the indices were used on a monthly basis to get a more robust understanding of the whole season of the Vineyard.

For objectives 1, 2 and 3 -

Statistics using NDVI can reveal the required insights at a basic level.

A median operation was performed on all the available images in a month, to get the median value of each pixel during that month.

Using a “median” is important since it has the best chance of removing cloudy/foggy days from each pixel in that month.

For NDVI, each month image was taken, and then a single median value was taken ie., the most common NDVI value for that month, and it was used to highlight any pixel/area of 100m2, that was 10% below that median of the field .

This shows the pixels/areas where some plant stress is visible/likely.

Looking for pixels with NDVI values greater than 15% of the median could highlight potential Weed locations for each month.

For objective 4 -

Median NDMI was taken for each month, and then a single median value was taken ie., the most common NDMI value for that month, and it was used to highlight any pixel/area of 100m2, that was 60% below that median of the field to get Water Stressed regions.

The 60% was decided due to the flat nature of the NDMI. It changes very lightly across a field and does not have a contrasting high and low value like typical vegetation indices.

Moisture values in nature/agriculture rarely have sharp discontinuities, hence the need to look for very high/low outliers to get water overuse/water stress.

For objective 5 -

This requires atleast one higher resolution imagery, ie., 1.5m or higher, during the season with atleast 4 bands including NIR.

That would allow the use of a strong soil-noise resistant vegetation index, and pinpoint the higher value pixels and count each of them to get a estimate of number of plants in the field.

Conclusions and Approach -

The code provided along with this summary was written to minimize data movement, and inference time of the analysis, and provide a “web map” based visualization of the outputs that come from analysis.

Dask Clusters, Xarray datasets, and STAC metadata of satellite imagery was used to perfom the analysis.

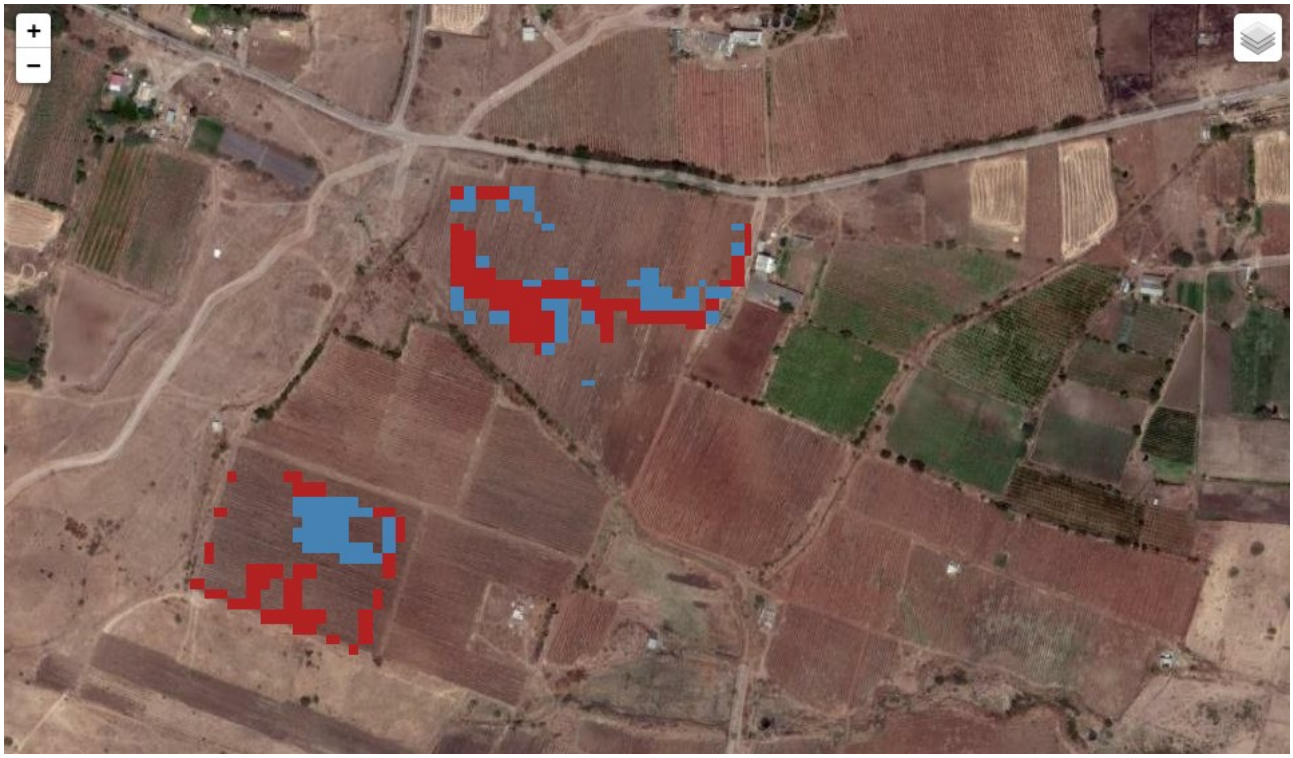
GDAL and Rasterio were used to read and write Geotiff and PNG files, and also to make PNG files have an RGB color palette provided to them.

Folium was used to overlay the RGB color coded PNG files, and each month’s Plant and Water stress pixels were overlaid on the given 2 fields.

The PNG outputs can also be used on a Mobile based map, or a broswer/web based map, if a Pilot asks for inference that can be shown on multiple devices.

Hence the approach to this assignment, was not only from a Data Science point of view, but also from Computation and Data sharing point of view, where the output from a Data Science based Analysis is also made accessible for sharing and viewing to any person.

Sample Output Map -



Red Pixels show Plant Stress
Blue Pixels show Water Stress